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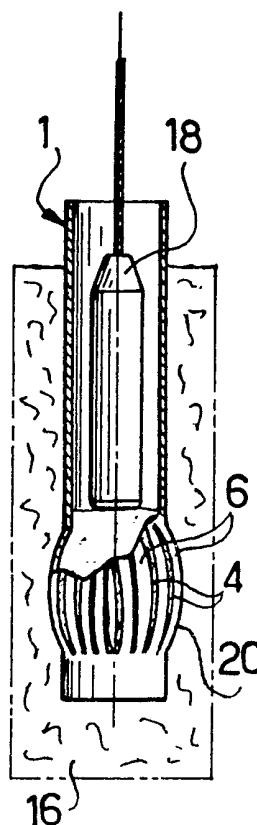
(58) Field of search

E1H

(54) **Improvements in or relating
to foundation piles**

(57) A foundation pile is produced using a tube (1) which is radially outwardly deformable in one or more regions along its length, eg having longitudinal slits (4) in such regions defining tongues (6) therebetween. The or each such region deforms outwardly during filling of the tube with concrete or analogous material, producing one or more anchoring swellings (20) which provide the pile with improved resistance to compression and tension as compared with conventional piles.

FIG. 2c



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FIG. 1

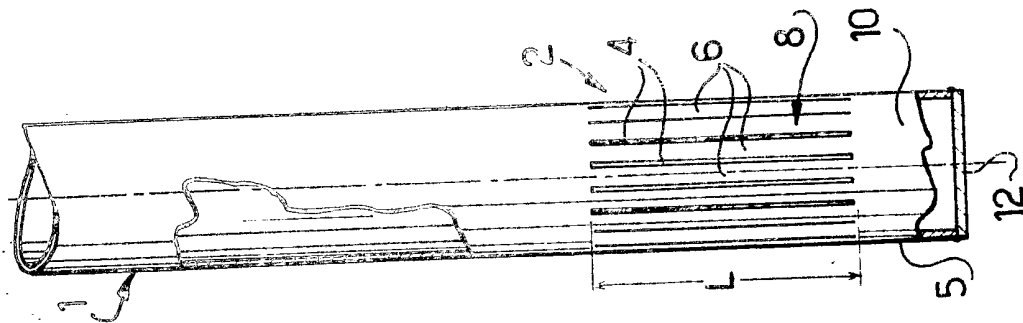


FIG. 2a

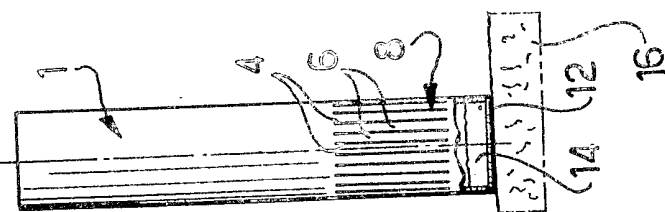


FIG. 2b

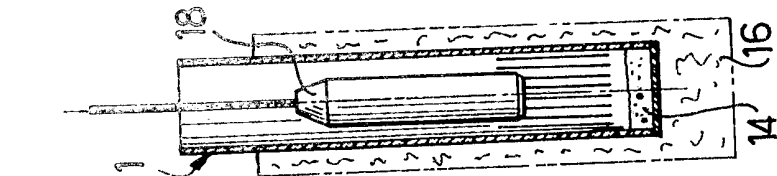


FIG. 2c

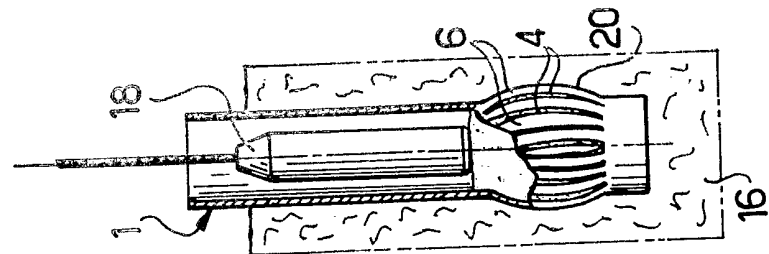


FIG. 2d

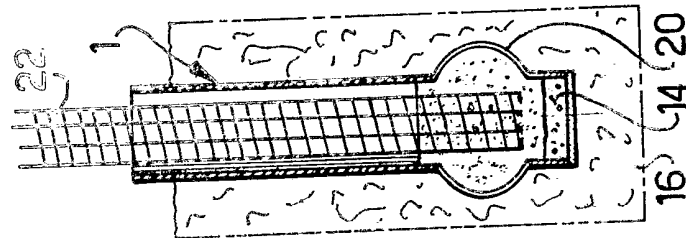
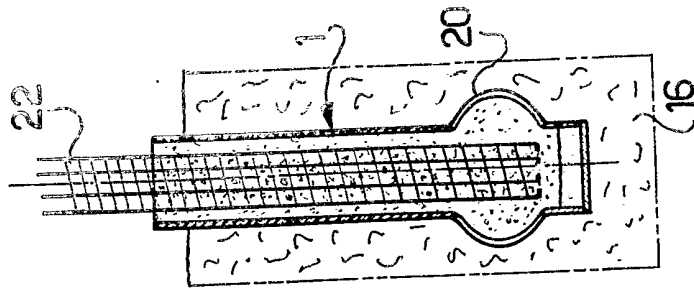


FIG. 2e



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SPECIFICATION

Improvements in or relating to foundation piles

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Field of Invention

The invention relates to foundation piles and concerns a foundation pile, a tube or preparatory pile for use in formation of a foundation pile, and a process for producing a foundation pile.

10

Background to the Invention

It is known that in a number of cases

15 foundation piles must be resistant to compressive and tensile stresses, and often the same foundation pile is subjected alternately to the two types of stresses according to the external circumstances.

20 For example, consider the foundations of a subterranean hollow building, such as a reservoir, a dry-dock or a tunnel, which are subject to the effect of the tide. The foundation piles act as supports at low tide and serve as an anchorage for impeding the structure to be raised and floated at high tide.

25 Another case is that of the foundations of metallic pylons or masts supporting high voltage lines where, according to the orientation and strength of the wind, the piles act as either bearing or drawing rods.

30 Known foundation piles generally comprise a tube (or preparatory pile) filled with concrete or an analogous or equivalent material, preferably provided with an inner framework for reinforcing the concrete.

35 It is accordingly an object of the present invention to provide a novel tube or preparatory pile enabling production of a foundation pile having improved resistance to compression and tension as compared with known piles.

Summary of the Invention

45 In one aspect, the present invention provides a pile of the type including a tube or preparatory pile filled with concrete or an analogous or equivalent material preferably provided with an inner framework, characterized in that said tube comprises means rendering it radially outwardly easily deformable onto one or several parts of its length so as to form after filling of the tube with concrete or analogous material one or several anchoring swellings or bulbs.

50 By using a tube which is radially outwardly deformed during filling with concrete to produce one or more anchoring swellings, the invention enables production of a pile which has improved resistance to compression and tension as compared with conventional piles. Furthermore, as will be apparent later, such a pile can be produced by a process similar to that used for conventional pile production, and this may be done comparatively simply

and cheaply using comparatively simple, cheap machinery with inexperienced workers.

According to a preferred embodiment, said deformable means comprises a plurality of longitudinal slits of predetermined length formed in the side wall of said tube in the or each deformable region, said longitudinal slits defining therebetween a plurality of deformable tongues or splines. Preferably, these tongues or splines are of substantially the same width and length.

Advantageously, the only or lower deformable region, preferably constituted by longitudinal slits, is located in the vicinity of the lower part of said tube and thus of said pile.

80 The present invention also provides a tube or preparatory pile for use in production of such a pile, wherein the tube comprises means rendering it radially outwardly deformable in one or more regions along its length, such region(s) being deformable, in use, during filling of the tube with concrete or analogous material to produce one or more anchoring swellings.

90 In a further aspect of the present invention also provides a process for preparing said pile with improved strength with respect to compressive and tensile stresses, comprising the driving in of a tube or preparatory pile, the bottom of which is provided with a plug, into the ground by boosting onto said plug and after driving it at the required depth, the filling in of said tube with concrete or an analogous or equivalent material, characterized in that said tube is previously provided with means rendering it radially outwardly easily deformable, foreseen onto one or several parts of its length, preferably constituted by longitudinal slits performed in the wall of said tube onto a predetermined length and defining between them a plurality of small tongues or splines easily deformable; introducing a little amount of concrete or an analogous material into the tube so as to form the said plug; after driving in of the tube, adding thereto small amounts of concrete or analogous material which are tamped or rammed so as to cause the expansion of the concrete or analogous material outwardly and the simultaneous deformation of said little tongues or splines thereby forming one or several anchoring swellings or bulbs, and finally filling in fully the tube with concrete or an analogous material.

120 Other features and advantages of the invention will appear clearly from the following detailed description with reference to the accompanying drawings wherein:

125 *Figure 1* shows a tube or preparatory pile according to the invention for use in formation of a foundation pile in accordance with the invention; and

Figures 2a to 2e illustrate successive steps in production of a foundation pile.

130

Detailed description of the Drawings

Fig. 1 shows a metallic tube (or preparatory pile) 1 having an open upper end, the lower end being closed by a cover 12 welded thereto. The side wall 5 of the tube is initially of generally circular cylindrical configuration, as shown, and includes in region 8 in a lower part 10 thereof, located some decimeters above the lower end of the tube, a slitted zone 2 comprising a series of longitudinal slits 4 of length L extending around the circumference of the tube and defining a series of tongues or splines 6 therebetween. In the illustrated embodiment, the slits 4 are equally spaced and of the same length, so that the tongues 6 are all of the same width and length.

The tongues 6 are comparatively easily deformable in a radially outward direction, and will deform in this way on filling of the tube 1 with concrete or analogous material, forming a swelling or bulbous region which acts to anchor the resulting pile providing the pile with improved resistance to compression and tension as compared to conventional piles.

In a modification (not shown) one or more further slitted zones, similar to zone 2, may be provided above region 8. In all cases it is preferred that the only or lower slitted zone, eg zone 2, is located in the vicinity of the lower part 10 of the tube which will form the lower part of the resulting pile.

Fig. 2 illustrates successive steps in production of a foundation pile using tube 1.

In a first step, shown in Fig. 2a, the tube 1 is placed vertically along the guiding mast of a pile driving machine (not shown). The machine may be of conventional construction, eg comprising a mobile lower frame which may or may not be self-propelled, a winch with one or several drums, driven by an electric, thermic or other type of motor, the guiding mast being provided with the necessary pulleys or wheels.

A small amount of concrete or analogous or equivalent material is introduced to the interior of tube 1 so as to form within the said tube a concrete plug located against end cover 12, as shown in Fig. 2a.

This plug 14, of course, must not extend in any way beyond the lower limit of slitted zone 2 of tube 1.

The second step, shown in Figure 2b, concerns the driving of the tube into the ground 16 by boosting or driving onto plug 14 with the aid of a tamper 18 driven by the machine winch, in a known manner. An automatic boosting hammer can also be used to act on plug 14 located at the base of tube 1 with the aid of a boosting mandrel. Boosting is stopped when tube 1 is at the required depth where its driving or extracting resistance is sufficient.

Then follows a step illustrated in Figure 2c, which comprises adding small amounts of

concrete or analogous material which is tamped with the aid of tamper 18. As shown in Fig. 2c, the tamping causes outwards expansion of the concrete or analogous material with simultaneous deformation of tongues 6, resulting in formation of an anchoring swelling or bulb 20.

The deformation of tongues 6 is preferably monitored from the ground surface, for instance by measuring the driving in of the upper part of the tube 1 as well as monitoring the added amount of concrete or analogous material and the final level of the concrete within the tube.

Figure 2d shows the final swelling 20.

A reinforcing framework 22, shown in Figs. 2d and 2e, can be introduced to tube 1 either before or after production of the swelling 20.

The final step of the process for forming the foundation pile is to fill the tube completely with concrete or analogous material as shown in Fig. 2e so as to obtain the finally formed finished pile.

Of course, as previously mentioned, several swellings or bulbs can be produced in favourable ground layers, by providing several zones of slits 4 with their associated tongues 6, so as to increase the strength or resistance of the pile with respect to driving and above all with respect to extraction or pulling out.

Also, in the case of embodiments using a framework 22, the tamper 18 must be designed so as to be able to slide easily within the framework 22, before production of the swelling.

It will also be noted that during formation of the swelling the tube will shorten slightly but this is not a drawback in the practice. Indeed, such a shortening can be taken into account when determining the initial length of the tube.

It will be understood that by using a tube and process in accordance with the invention, a foundation pile according to the invention can be produced.

It will also be understood that the invention includes within its scope all the means constituting technical equivalents to the described and illustrated means, as well as all the combinations thereof, and various modifications thereof.

For example, although not shown in the Figures, an external strip or film, eg of a sufficiently resistant plastics material, may be located in region 8, covering the slits. Such a strip or film would thus surround the tube and protect the deformable tongues 6: the film would not be damaged on driving in of the tube 1, but could be ruptured on formation of the anchoring swelling or bulb 20.

CLAIMS

1. A foundation pile comprising a tube filled with concrete or analogous material, wherein said tube comprises means rendering

it radially outwardly deformable in one or more regions along its length, the tube having been deformed during filling with concrete or analogous material to produce one or more anchoring swellings.

2. A foundation pile according to claim 1, wherein said means comprises a plurality of longitudinal slits of predetermined length formed in the side wall of the tube in the or each region, said longitudinal slits defining therebetween a plurality of radially outwardly deformable tongues.

3. A foundation pile according to claim 2, wherein said tongues are of substantially the same width and length.

4. A foundation pile according to any one of claims 1 to 3, wherein the or the lower deformable region is located in the vicinity of the lower part of tube and thus of the foundation pile.

5. A foundation pile according to any one of the preceding claims, wherein the concrete within the tube is reinforced.

6. A foundation pile substantially as herein described with reference to, and as shown in, the accompanying drawings.

7. A tube for use in formation of a foundation pile, wherein the tube comprises means rendering it radially outwardly deformable in one or more regions along its length, such region(s) being deformable, in use, during filling of the tube with concrete or analogous material to produce one or more anchoring swellings.

8. A tube according to claim 7, wherein said means comprises a plurality of longitudinal slits of predetermined length formed in the side wall of the tube in the or each region, said longitudinal slits defining therebetween a plurality of radially outwardly deformable tongues.

9. A tube according to claim 8, wherein said tongues are of substantially the same width and length.

10. A tube according to any one of claims 7 to 9, wherein the or the lower deformable region is located in the vicinity of the lower part of the tube.

11. A tube according to any one of claims 7 to 10, wherein the or each deformable region is covered by material adapted to rupture on deformation of the tube in use.

12. A tube for use in formation of a foundation pile, substantially as herein described with reference to, and as shown in, the accompanying drawings.

13. A process for producing a foundation pile comprising driving into the ground to a desired depth a tube comprising means rendering it radially outwardly deformable in one or more regions along its length; introducing to the interior of the driven tube small amounts of concrete or analogous material and tamping said material so as to cause expansion of the material outwardly producing

deformation of said region or regions, thereby forming one or more anchoring swellings; and thereafter filling the tube with concrete or analogous material thereby to form said foundation pile.

14. A process according to claim 13, wherein deformation of said region or regions is monitored from the ground surface by measuring the driving in of the upper part of tube as well as the added amount of material and the final level of material within the tube.

15. A process according to claim 13 or 14, using a tube wherein said means comprises a plurality of longitudinal slits of predetermined length in the side wall of the tube in the or each region, said longitudinal slits defining therebetween a plurality of radially outwardly deformable tongues.

16. A process according to claim 13, 14 or 15, wherein a reinforcing framework is located within the tube.

17. A process for producing a foundation pile substantially as herein described with reference to the accompanying drawings.

18. A foundation pile produced using a process in accordance with any one of claims 13 to 17.

19. A foundation pile produced using a tube in accordance with any one of claims 7 to 12.

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